April 1974 B74-10011

NASA TECH BRIEF

Lewis Research Center

Casting Copper to Tungsten for High-Power Arc Lamp Cathodes

The largest space environment chamber in the world is operated at the Lewis Research Center's Plum Brook Station. Two 400-kilowatt argon arc lamps are used as a radiation source for the solar simulator of this chamber. The power rating of each lamp is about 20 times the power rating of today's largest commercially available lamp.

One important component of these lamps is the cathode which consists of a thoriated tungsten disk bonded into a copper body. The thoriated tungsten is used as a low-work-function emitting surface for the thermal emission of electrons. During operation, the electric arc attaches itself to the upper edge of an inverted cone machined in the center of the tungsten disk. As a result, there is a large amount of localized heating of the tungsten. In order to prevent the tungsten from melting, there must be a good thermal path between the emitting surface and the cooling water circulating through the hollow body of the cathode.

The main problem which affects the operating life of the cathode, and thus the life of the lamp, is the bonding of the thoriated tungsten to the copper electrode during the cathode casting process. A poor bond between the copper and tungsten, or voids in the copper, reduce the thermal conductance and the tungsten starts to melt. Many of the cathodes previously made for the arc lamps failed after a few hours use because of excessive melting of the tungsten.

When copper is cast onto tungsten, there is a tendency for voids to form at the interface, caused by incomplete wetting of the tungsten by the copper. These voids can be eliminated by adding a wetting agent such as nickel to the copper during the casting process. This can be accomplished by a two-step vacuum casting process. First, a small amount of copper and nickel are cast onto the thoriated tungsten insert. Then the coated tungsten insert is recast with more copper to form the electrode, resulting in the dilution of the nickel in the casting to 0.5% by the additional electrode copper. A good bond at the copper-tungsten interface results in good thermal conductance through the cathode and thus a long-lived cathode for such high-power arc lamps.

Notes:

1. Cathodes made by this process have withstood more than 110 hours of operation in the 400 KW arc lamps at the Lewis Center.
2. Further information is available in the following report:
   NASA TM-X-2865 (N73-27451), Casting Copper to Tungsten for High-Power Arc Lamp Cathodes
   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B74-10011
3. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B74-10011

Patent Status:

NASA has decided not to apply for a patent.

Source: Herbert A. Will
Lewis Research Center
(LEW-12169)

Category 04